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ORIGINAL PAPER

Effective environmental governance and outcomes for gold mining in Obuasi and Birim North Districts of Ghana

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Abstract Environmental governance of mining has been central in contemporary discourse of the development of mining projects in Africa and parts of the developing world. This paper assesses the effectiveness of environmental governance of gold mining in Obuasi and Birim North Districts of Ghana and the nature of outcomes that effective governance produces for communities and the environment. A survey of four communities and interviews of 384 respondents were conducted using questionnaires, focus group discussion and field observations. An index of the value of responses was created to measure the effectiveness of environmental governance using five variables (participation, accountability, fairness, partnership and institutional quality). A logit regression model was also used to determine the nature of outcomes produced by effective environmental governance for communities and the environment. The results showed that environmental governance was on the average effective and produced outcomes which were beneficial for communities and the environment. The study recommended an expansion of the scope and an increase in the standards of environmental governance to guarantee uninterrupted access of communities to environmental resources.

Keywords Environmental governance · Effective · Outcomes · Gold mining

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Introduction

Balancing effective environmental governance with the extraction of mineral resources is a major challenge confronting governments, mining companies and local communities. Mining activities bring variety of actors whose interest may stand opposed. Environmental governance mediates not only between the opposing interests but also between them and nature. Environmental governance brings together a range of state and non-state actors to engage in discourses and interaction through which processes and mechanisms evolve to the interest of individuals and groups as well as determining the nature of environmental outcomes.

Mining is an important social and economic activity in many African countries. About 69 % of African countries rely on the mining industry as the largest export sector (Sinkala 2009). Mineral exports contribute between 25 % and 90 % of the annual export earnings of 13 African countries (Ericsson 1991). In Ghana, the mining sector accounts for an average of 11.88 % of government revenue for the period 1990 to 2008, about 5 % of Gross Domestic Product (GDP) for the period 1993 to 2008 and an average of 39.1 % of total merchandise export for the period 2000 to 2008 (Minerals Commission 2010; Miles 2002). The artisanal small-scale mining (ASM) sub-sector also contributes on the average about 12 % of the total gold produced and 89 % of diamonds production from 2000 to 2008 (Minerals Commission 2004).

In the last three decades, the activities of mining have expanded in many mineral-producing and mineral-exporting African countries. The expansion in the activities of mining across the continent of Africa is motivated by neoliberal policies which encourage the movement of transnational private capital into the sector and new technologies such as surface and open-cast mining. At the launch of structural adjustment in the 1980s, African countries with good mineral potential were aided by the World Bank and other bilateral

actors to direct their energies at creating favourable conditions for attracting transnational mining companies. A response to this advice resulted in the liberalisation of the sector accompanied with huge incentives such as open-ended offshore retention, tax holidays and exemptions of custom and excise duties on equipment imported for mining.

The research problem

The expansion of the activities of mining has resulted in heightened environmental and social challenges including the destruction of land, water resources, vegetation and community livelihoods (Singh 2005; World Bank 2002). Mining activities have also resulted in the dislocation of resettlements and displacement of thousands of farmers from access to agricultural lands (Akabzaa 2000). In addition, environmental pollution as a result of mining poses public health threat. A report of Ghana's Ministry of Environment and Science (2002), reveals that between 1980 and 1989, 519 mammals mostly bats and rodents were found dead at cyanide-extraction gold mine leach ponds in California, Nevada and Arizona. In 1996, an accidental cyanide spillage of Teberebie Goldmine Limited into the Angonaben Stream in the Western Region of Ghana caused considerable damage to fish, crops and farms, and threat to the health of residents in the area (Akabzaa 2000).

Different actors at different levels have been responding to the environmental and social challenges of mining using different approaches, mechanisms and instruments to mitigate their impacts or prevent them where possible. These approaches, mechanisms and instruments include environmental impact assessment, environmental taxes like reclamation bonds, environmental permitting standards such as pollution emission levels; economic (market-based) instruments such carbon trade or transferable emission permits; and voluntary agreements such as eco-labels, corporate social responsibility, the Extractive Industry Transparency Initiative, the United Nations Global Compact, and Clean Development Mechanism (Lemos and Agrawal 2006; Persson 2004; and Jordan et al. 2003). Local communities have historically relied on customary systems in regulating the quality and use of land and the environment (Kasanga and Kortey 2001). Civil society organisations including non-governmental organisations (NGOs) have been mobilising and articulating the concerns of communities affected by mining as well as demanding accountability of governments and mining companies. Over 500 multilateral environmental agreements and a plethora of international organisations, doing the best they can, to respond to environmental challenges that range from climate change to persistent organic pollutants (Kanie and Hans 2004). In spite of the prevalence of wide variety of environmental governance instruments, environmental challenges of mining persist especially in mining areas. The key questions to ask include whether the environmental governance processes and mechanisms are effective or mere technical tools for compliance?

The objective of this paper is to:

1. Determine the effectiveness of environmental governance mechanism in the Obuasi Municipal Assembly in Ashanti Region and Birim North District Assembly in Eastern Region of Ghana.
2. Analyse the impact of outcomes produced by environmental governance on local communities in the study area.

Conceptualising environmental governance

According to Cleaver and Franks (2005), 'the concept of governance, as employed in development thinking, is characterized simultaneously by diversity of definitions'. Different scholars and institutions of governance characterize the concept differently. Environmental governance which is an aspect of the broader concept of governance is equally confronted with diversity of definitions and approaches. Salih (2002) defines environmental governance as 'how societies organise themselves to manage their environment and deal with fundamental environmental problems'. Lemos and Agrawal (2006) view environmental governance as a set of 'regulatory processes, mechanisms and organisations through which political actors influence environmental actions and outcomes'. Harashima (2000) defines environmental governance as 'the way societies deal with environmental problems'. 'It concerns interactions among formal and informal institutions and actors within society that influence how environmental problems are identified and framed'. Durant et al. (2004) consider environmental governance aspect of governance as 'the ways in which societies worldwide have sought to advance their legitimate interests in reducing environmental and natural resources risks, in ensuring that citizens' rights are protected equitably from these risks; and in allocating roles, responsibilities, and resources more rationally to afford the greatest protection to all.'

Scholars have studied environmental governance from a variety of perspectives including theoretical and empirical perspectives. In the empirical approach which this paper follows, there is increasing acknowledgement of the importance of measuring governance quantitatively (Dasgupta et al. 1995; Coglianese and Nash 2001; Miles 2002; Wang and Di 2002; Kaufmann and Kraay 2007; Steiner et al. 2003; Durant et al. 2004; Braga and Irina 2004; Wertz-Kanounnikoff and Chomitz 2008). All of these authors have one time or the other, applied a quantitative approach or sought to reduce aspects of governance and more specifically environmental governance to measurable phenomenon.

Materials and methods

Study area

The study area included four communities, i.e. Binsere and Dokyiwaa in the Obuasi Municipality in the Ashanti Region, and Adausina and Yayaaso in the Birim North District in the Eastern Region of Ghana constitute the area of study (Figs. 1 and 2). Farming of cash and food crops and production of small ruminants is the main occupation of the people in the four communities. The effect of mining on farming has often been a major source of tension between farmers and mining companies. The two Districts host two of the top seven mining companies AngloGold Ashanti and Newmont Ghana Gold Limited (Table 1).

The Obuasi municipality covers a total land area of 162.4 km^2 and has over a century of experience of gold mining. The Obuasi mine concession covers approximately 36.2 km^2 representing 22.3 % of the total land area of the Municipality. Most of the settlements in the Municipality are within the concession of AngloGold-Ashanti Ltd or very close to its facilities (Obuasi Municipal Assembly 2006). Binsere and Dokyiwaa are located very close to the spent cyanide containment pond of AngloGold. The Feena River, which is being used by these communities for watering their animals and for domestic purposes, separates Dokyiwaa from this spent cyanide pond.

The Birim North District Assembly, on the other hand, covers an estimated total land area of 1,250 km^2 representing about 6.5 % of the total land area of the Eastern Region. The District, unlike Obuasi, has a relatively recent history of large scale gold mining (Birim North District Assembly, 2006). There is a deliberate action on the part of government to open up 2 % of the productive forest reserves of the country for surface mining. About 15 forest reserves have been affected by mining, and an estimated 13,165 ha of forest reserves are under mining lease. In the Birem North District of the Eastern Region, about 13 % of the Ajenua Bepo Forest Reserve one of the last vestiges of Ghana's forest has been allocated for surface gold mining operations.

The Environmental Protection Agency (EPA) of Ghana rated the companies operating in the two districts as poor in its environmental performance rating and disclosure programme released in late 2010. The programme known as AKOBEN is an initiative to periodically assess and disclose the environmental performance of mining and manufacturing operations using a five-colour rating scheme. The five colours are gold for excellent, green for very good, blue for good, orange for unsatisfactory and red for poor.

Data

In order to determine the effectiveness and the nature of outcomes that environmental governance produced for communities and the environment, we conducted a survey of the four communities and interviews of 384 respondents. The survey and interviews were conducted using questionnaires, focus group discussion and field observations.

Using the data gathering instruments, we gathered data from a variety of primary sources namely; individuals and relevant committees in the four selected communities, staff of the respective assemblies, chiefs, queen mothers, assembly members, fetish priests, teachers, and other organised groups and associations in the study area. With the help of three trained assistants, the questionnaires were administered from August to September 2009 and we had a response rate of 97.7 %. The questions for all four communities were the same, in order to provide a basis for comparison. Other sources of primary data included staff and officials of NGGL, EPA, Minerals Commission, NGOs, UNDP, and other relevant institutions and individuals in the realm of environmental governance. In addition to the primary sources, we reviewed secondary sources such as published and unpublished books, reports, academic journals, policy documents, parliamentary legislations, regulations, minutes of meetings, articles, newspaper reports, notices, letters, statements, pictures, documentaries, and the internet.

Data collected in the field were grouped into two main types, descriptive and multivariate data. The descriptive data were used to describe the behaviour of individual variables in the data set with the help of tables, diagrams, graphs and figures. Multivariate regression analysis was applied to explain the key variables influencing environmental governance effectiveness as well as the outcomes produced by environmental governance for communities and the environment. The main variables used in the multivariate regression analyses were participation, accountability, fairness, partnership, and institutional quality.

Techniques of measurement

The paper argues that environmental governance instruments and mechanisms in the mining sector of Ghana are effective and produce outcomes which are beneficial for communities and the environment. We made a prior determination that where the t statistic was significant, it meant that environmental governance was effective and outcomes were positive for communities and the environment. The paper used two main approaches to measure the central hypothesis. The first was the construction of an index to measure effectiveness of environmental governance (EEG) using the five variables of participation, accountability, fairness, partnership and institutional quality. The second approach was the estimation the nature of outcomes produced by effective environmental governance using a binary logit regression model.

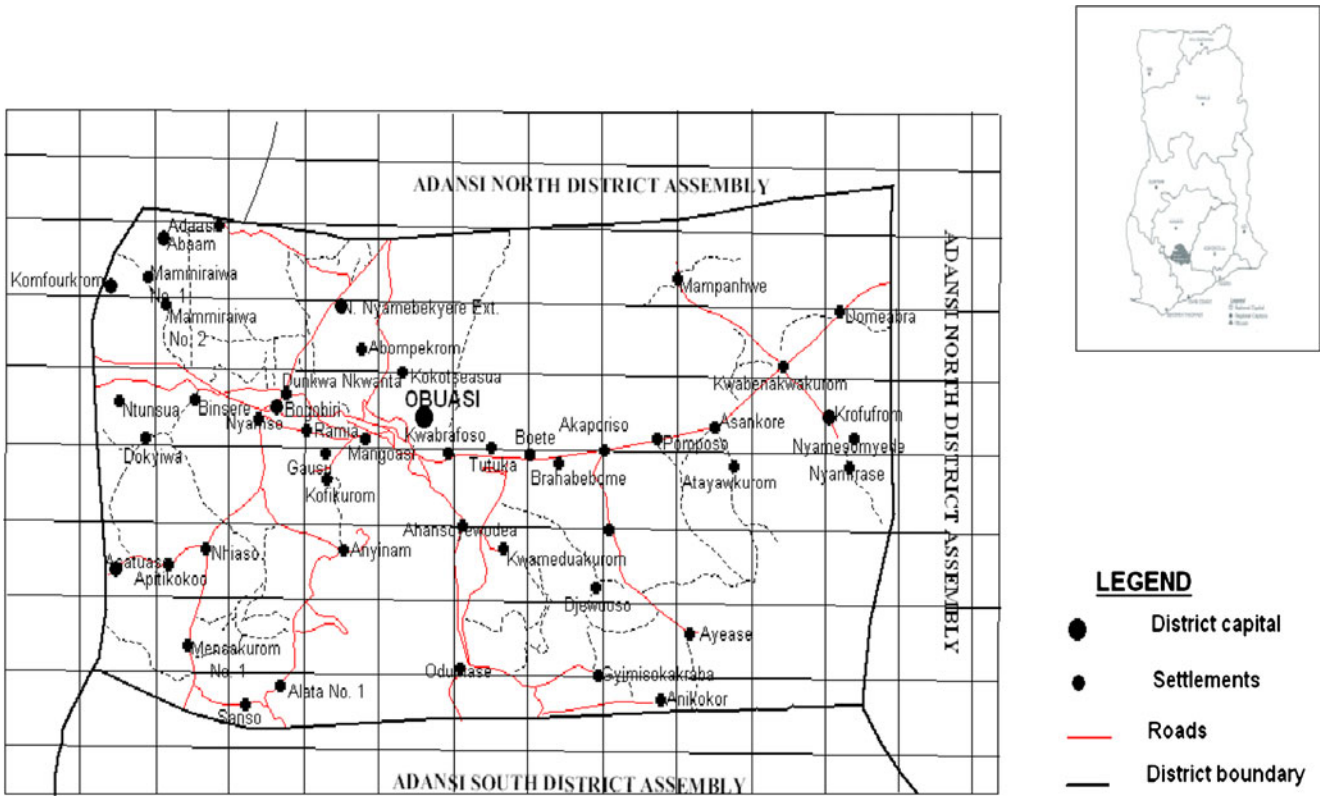

Fig. 1 Map of Obuasi Municipal Assembly

Construction of index of effective environmental governance

To construct the index using the five variables, we began by transforming the variables into actual measurable indicators as shown in Table 2. Based on Table 2, an index that measured EEG the variables was created. The indexation was used in order to derive a single measure of EEG using the five variables. Two methods were used to construct the index as follows: For each of the five variables, an unequal number of questions were asked to which respondents answered *yes* or *no*. A *yes* was assigned a value 1 and a *no* 0[1]. The value for each variable was a sum of the numerical values assigned to each question based on the responses.

The first method of constructing the index EEG was a raw sum of the various variables. This index is called EEG1 (raw sum of the five variables that measure effective environmental governance). In this method, the weight attached to each variable depends on the number of questions asked for that variable. For the second method, principal component index scores[2] were constructed from the five variables that measure effective environmental governance. The scores were then standardized to have a mean of 0 and standard deviation of 1. This index is called EEG2 (Standardized normalized score of effective environmental governance generated from principal components from five measures of effective environmental governance).Where the value of EEG1≥50 % of the maximum value, it meant that environmental governance was effective.

Estimation of outcomes produced by environmental governance

Again, to estimate the nature of outcomes produced by effective environmental governance, we transformed the outcomes variables into measurable indicators as shown in Table 3.

We then applied the binary logit regression model to estimate the effect of environmental governance on environmental outcomes. In other words, the logit regression model was used to determine whether effective environmental governance has positive effects on outcomes. Positive effect means that effective environmental governance leads to outcomes which are beneficial for communities and the environment, and negative effect mans that effective environmental governance leads to outcomes which are not beneficial for communities and the environment. The logit regression model used is:

$$EO = \alpha + \beta EEG + Z\gamma + \varepsilon \quad (1)$$

Where:

EO environmental governance outcomes for communities and the environment (the dependent variable) which

[1] For questions with sub-questions, the yes-no responses were assigned same values and averaged over the number of sub-questions to obtain the single value for that question.

[2] This was obtained using the 'pca' command in STATA.

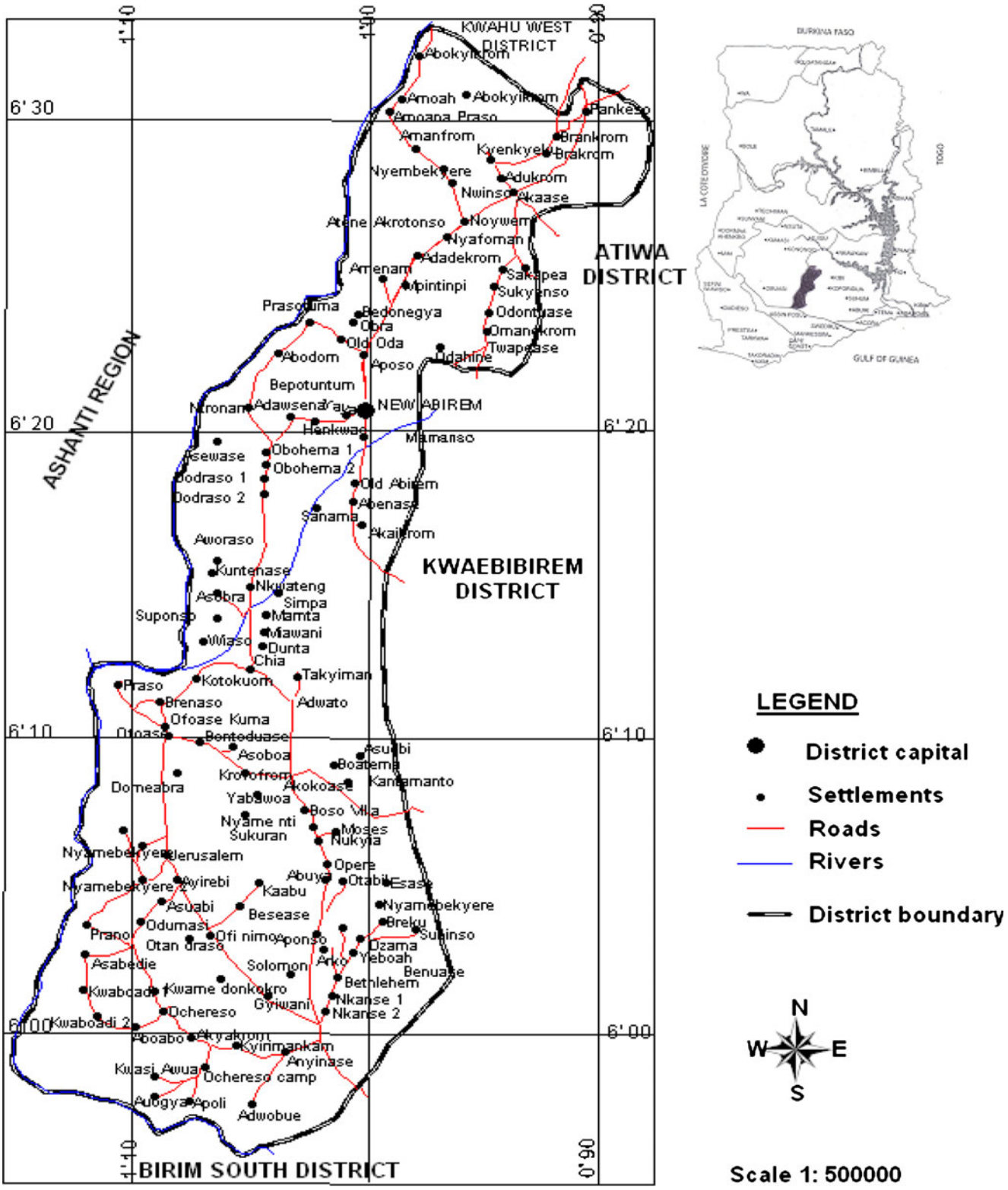

Fig. 2 Map of Birim North District Assembly

takes the value of responses as 1 if positive, and 0 if not positive). Each outcome measure is an indicator variable that takes on the value of 1 if the desired outcome is present and 0 if not present. Where an indicator defined in the data set was not responded to, it was excluded from the relevant analysis. Thus, a

Table 1 Top seven gold mining companies in Ghana

Company	Mines	Production (oz)				
		2004	2005	2006	2007	2008
AngloGold Ashanti (AGA)	Obuasi	392,626	391,382	387,093	359,962	357,152
	Iduaprim	219,310	201,701	183,534	185,505	214,712
Gold Fields Ghana Ltd (GFGL)	Atuabo	550,340	718,411	720,109	657,062	628,864
	Damang	296,169	229,549	217,932	180,434	197,027
Central African Gold Ltd (CAGL)	Bibiani	157,988	114,979	43,213	23,918	28,162
Golden Star Resources Ltd (GRL)	Bogoso/Prestea	155,226	136,668	108,931	128,020	167,408
	Wassa	–	85,623	97,613	126,062	125,468
Med Mining Company (MMC)		1,220	1,689	2,637	2,717	2,617
Chirano Gold Mines Ltd (CGM)	Akoti/Etwebo	–	21,385	126,707	115,450	120,983
Newmont Ghana Gold Ltd (NGGL)	Ahafo	–	–	202,126	456,448	524,671
	Akyem	–	–	–	–	–

Source: Minerals Commission 2010

Table 2 Definition of indicators and other concepts

Variable	Indicators	Measurement of indicators
Effective environmental governance (EEG)		A composite index made of the five variables that measure or determine effective environmental governance
Participation	KNOWESIA	Awareness and knowledge of ESIA as a legal requirement for large-scale gold mining in Ghana
	INV-ESIA	Aware that companies are obliged to involve community members in ESIA study
	INFO-ACCESS	Access to information needed for informed contribution and discussions on environment and property
	TIMELINESS	Timeliness of notices on decisions and issues
	INV-DECISIONS	Composite index for involvement of community in decision making about mining
Accountability	INFO-DISC	Decisions, performance and reports fully disclosed and accessible to communities
	FEEDBACK	Availability of agreed criteria for feedback from mining companies and government agencies to communities for determining compliance with agreed actions
	COMPLIANCE	Mining Company in area is complying with environmental protection laws and community issues
	INFLUENCE	Composite index for capacity of community to influence officials of government and mining company in locality
Fairness	TREATMENT	Composite index for treatment of communities and mining companies by Government officials.
	PROP-DIST	Composite index for proportionate distribution of environmental benefits and burdens of mining by government
Partnership	AGREEMENT	Agreement (oral or written) or joint project with community exists and known to be mutually beneficial
	FAIRPROCESS	Terms and conditions of agreement negotiated fairly and agreed by all parties
Institutional quality	ACCESS	Community has access to government officials and institutions when needed
	READINESS	Readiness of officials/institutions to listen and respond to community concerns arising from gold mining
	COMPEL	Community has confidence in the power of EPA and local assembly to compel mining companies to comply with environmental laws and their concerns.
	DISPS-RE	Community has confidence in the ability of EPA and local assembly to resolve disputes fairly
	PROTECT	Community has confidence in the capacity of EPA to protect community land, water and property from destruction by gold mining activities
Indexes of effective environmental governance	EEG1	Raw sum of the five variables that measure effective environmental governance
	EEG2	Standardized normalized score of effective environmental governance generated from principal components from five measures of effective environmental governance

Source: Darimani 2011

Table 3 Definition of environmental governance outcomes

Outcome variables	Definition
VOICE	Community members have voice in decision making
S-LIVELIHOOD	Support for livelihood enhancement projects
R-INCIDENCE	Reduced incidence of conflicts and tension
A-SKILLS	Acquisition of new skills for resource management
U-ACCESS	Uninterrupted access to environmental resources

Source: Darimani 2011

number of indicators were excluded from the analysis.

A is the constant or intercept which is the value of EO when all the proxies equal zero.

B is the regression coefficient of the sample which determines the effect of EEG on EO. This is the coefficient of interest and its statistical significance will be determined from the T statistics from the regression.

Z is a vector of demographic characteristics of individual respondents including age, education, gender, and locality.

EEG is the environmental governance (the independent variable).

γ is a vector of parameters, and

ε is error term.

Three forms of Eq. (1) were estimated. In the first specification, the individual variables that capture EEG were included. This means that there were five βs, one each for the five variables that measured EEG. The other two specifications included the two indexes of EEG generated from the construction of the index (i.e. EEG1 and EEG2). All estimations of Eq. (1) use the Eicker-White standard errors to correct for possible heteroskedasticity in the error term. In practice, the logit regression model and statistical techniques were estimated using STATA computer software programme.

Results and discussion

The paper uses some demographic characteristics of each locality as controls for the measurement and comparison within localities (Table 4). This is meant to guide policy and further work for the different demographic groups affected by mining in rural communities.

Effectiveness of environmental governance

Table 5 summarises the indexes used to measure various variables that determine effective environmental governance as wells as the single component indexes for the effectiveness of environmental governance. The individual indexes for the five components are reported in columns 2 to 5, and the two component indexes are reported in the last two columns of Table 5.

Table 4 Demographic characteristics of respondents

Characteristic	Percent of respondents	
Community		
Aduasena		29.4
Binsere	32.3	
Dokyiwaa		22.1
Yayaaso		16.7
Age		
≤20		18.0
21–30		28.9
31–40		22.4
41–50		17.7
>50		13.0
Gender		
Male		50.1
Female		49.9
Marital Status		
Single		27.3
Married	59.7	
Divorced		8.2
Separated		1.3
Widowed		3.5
Education		
No education		26.3
Primary	18.9	
JHS		43.7
SHS		7.4
University		0.9
Others		2.9
Sample		380

Source: Field Work 2010

In Table 5, EEG1 is a raw sum of the various indexes while EEG2 is generated by converting a score of the principal components of the five variables to standard normal distribution (zero mean and unit standard deviation). It is important to note that there are no significant differences in these indexes by the various demographic characteristics. All the variables, except accountability, received more than 50 % score in the measurement (Table 5). This also means that all the variables, except accountability, were significant. The raw total of all the five variables (EEG1) was 17 (Table 5).

The composite index was 9.14 which was approximately 53.8 % of the raw total (Table 5). Since the value of EEG1 (9.14) was more than 50 % of the maximum value of the sum of the numerical values of all the variables (17), it could be concluded that environmental governance was effective. The

Table 5 Effective environmental governance

	Participation	Accountability	Fairness	Institutional	Partnership	EEG1	EEG2
Scale	0–5	0–4	0–2	0–5	0–1	0–17	0–1
Total	290	357	281	356	371	203	202
Full sample	3.13	1.67	1.08	2.91	0.67	9.14	0
Community							
Aduasena	3.93	2.25	1.54	3.62	0.70	11.88	0.84
Binsere	2.65	1.32	0.89	2.65	0.68	8.46	−0.23
Dokyiwaa	3.16	1.68	1.20	2.83	0.55	9.97	0.27
Yayaaso	2.87	1.29	0.84	2.32	0.75	8.31	−0.24
Chi-square	145.86[a]	164.08[a]	190.52[a]	59.54[a]	7.57[b]	507.7[c]	606.02[c]
Age							
≤20	3.16	1.80	0.98	2.95	0.61	9.45	0.10
21–30	2.78	1.55	0.87	2.70	0.62	8.21	−0.25
31–40	3.08	1.57	1.13	2.88	0.71	9.36	0.02
41–50	3.19	1.77	1.08	3.15	0.67	9.26	0.04
>50	3.71	1.85	1.28	3.08	0.77	10.72	0.45
Chi-square	126.1[b]	74.14	15.19	32.44[b]	4.71	672.13	772.00
Gender							
Male	3.14	1.65	1.14	2.94	0.63	9.31	0.07
Female	3.11	1.69	0.92	2.88	0.70	8.93	−0.00
t statistic	0.24	−0.32	2.68[a]	0.33	−1.62	0.75	1.07
Education							
No education	2.81	1.74	0.95	2.71	0.68	8.88	−0.10
Primary	2.97	1.49	1.04	2.69	0.66	8.66	−0.12
JHS	3.16	1.68	0.94	3.13	0.65	9.02	−0.04
SHS and higher	3.86	2.21	1.39	2.91	0.64	8.31	0.31
Chi-square	88.95[c]	69.95[c]	97.57	31.72[a]	0.32	434.02	510.32

[a] Statistical significance at 1 % levels of significance

[b] Statistical significance at 5 % level of significance

[c] Statistical significance at 10 % level of significance

null hypothesis that 'environmental governance procedures and instruments in the mining sector of Ghana are effective', was thus rejected.

Outcomes of effective environmental governance

The second objective was to determine the nature of outcomes produced by effective environmental governance. Table 6 presents summaries for the full sample and summary of responses by various demographic characteristics (localities, age, gender and education). There were significant differences observed in all outcomes by locality but not by age and gender.

With respect to level of education, significant differences were observed for three outcomes (i.e. S-LIVELIHOOD, VOICE and A-SKILLS) but not for R-INCIDENCE and U-ACCESS. There is a correlation between effective environmental governance and the five outcome variables. This is because our composite index of 9.14 was more than 50 % of the maximum value of the sum of the numerical values of all the five determinants that measured effective environmental governance. Similarly, the scores for each of the five outcome variables are more than 50 %.

It is observed also that the pattern of responses is similar across the different outcomes. For example, all the variables had high score. Also, there were significant differences across localities for all outcome variables. This means that it does not matter how outcomes are measured, the relationship should be consistent across the different variables. For instance, it could be argued that once environmental governance is effective the outcomes produced would be beneficial whichever criteria was used in the estimation.

Estimation of regressions results

We use regressions to reinforce our argument that no matter how outcomes are measured, the relationship should be

Table 6 Outcomes variables by demographic characteristics

	S-LIVELIHOOD	Voice	R-INCIDENCE	U-ACCESS	A-SKILLS
Total	377	374	372	373	367
Full sample	71.1	65.8	69.6	68.6	60.0
Community					
Aduasena	88.2	83.5	77.1	76.4	85.6
Binsere	65.8	62.2	68.1	69.8	40.0
Dokyiwaa	57.1	51.2	57.1	54.8	44.6
Yayaaso	73.3	64.4	75.0	73.3	79.6
Chi-square	25.6[a]	24.0[a]	9.9[b]	11.3[a]	67.9[a]
Age					
≤20	69.1	67.2	77.6	79.1	63.1
21–30	70.9	62.7	73.1	69.4	58.7
31–40	76.5	65.9	65.5	65.5	53.6
41–50	66.2	65.1	70.3	72.3	67.2
>50	71.4	71.4	57.1	57.1	60.4
Chi-square	2.1	1.2	6.9	5.6	3.1
Gender					
Male	73.2	67.0	71.4	71.5	63.5
Female	69.7	64.3	67.7	65.6	56.2
T statistic	0.6	0.5	0.8	1.2	1.4
Education					
No education	61.1	57.3	57.3	64.7	46.1
Primary	67.7	63.1	63.1	66.2	61.9
JHS	72.2	64.4	64.4	67.8	65.3
SHS and higher	87.2	84.6	66.7	74.3	72.9
Chi-square	9.32[b]	8.97[b]	0.33	1.19	11.74[a]

Values represent percent of respondents

[a] Statistical significance at 1 % levels of significance

[b] Statistical significance at 5 % level of significance

consistent across the different variables (Tables 7, 8 and 9). Table 7 shows the individual measures of effective environmental governance as explanatory variables while Tables 8 and 9 include aggregated indices of effective environmental governance.

Table 7 shows that with the exception of the measure for institutional quality, all measures of effective environmental governance have significant effect on environmental outcomes.

The coefficient on the participation variable means that respondents who reported a unit higher on the participation index are 9 percentage points more likely to report that community members have voice in decision making. This is statistically significant at 5 % level.

Again, Table 7 shows that out of the five determinants of effective environmental governance, accountability consistently has significant impact on all outcome measures while institutional quality has no significant impact on any of the outcome variables. This means that accountability was considered an important determinant of effective environmental governance in generating environmental outcomes that are beneficial for communities and the environment. However, respondents believed that institutional quality was not considered to have contributed in any significant way to environmental governance outcomes.

Table 8 presents results from similar regressions but using the aggregated index measure of effective environmental governance as explanatory variable. The table shows that effective environmental governance has significant positive effect on all five outcome variables with magnitudes ranging from 2.5 percentage points to 6.5 percentage points. Coefficient of EEG1 (Table 8), suggests that respondents reporting a unit higher index of effective environmental governance are 5.7 percentage points more likely to report they acquire new skills for resource management. This is significant at 1 % level.

Table 9 presents results from similar regressions as Table 8 but using the EEG2, the index of effective environmental governance generated from the principal component index. Qualitatively, the results from Table 9 match that from Table 8. Effective environmental governance has statistically significant positive effect on all five environmental outcomes.

Quantitatively, the results from Table 9 indicate strong effects of effective environmental governance. For instance, comparing columns 3 from the two tables, the coefficients on EEG1 and EEG2 for the outcome 'S-LIVELIHOOD" (support

Table 7 Regression of outcomes variables on individual measures of EEG

Dependent variable		S-LIVELIHOOD	VOICE	R-INCIDENCE	U-ACCESS	A-SKILLS
Community						
	Aduasena					
	Binsere	−0.032	−0.044	−0.202	−0.083	−0.402[a]
		(−0.16)	(−0.19)	(−1.07)	(−0.42)	(−2.40)
	Dokyiwaa	−0.231	−0.291	−0.553[b]	−0.483[a]	−0.266
		(−1.02)	(−1.20)	(−2.87)	(−2.29)	(−1.44)
	Yayaaso	0.024	−0.129	−0.187	−0.046	0.138
		(0.12)	(−0.51)	(−0.81)	(−0.22)	(0.71)
Age						
	≤20					
	21–30	0.131	0.069	−0.154	−0.173	−0.149
		(1.34)	(0.64)	(−1.08)	(−1.32)	(−1.13)
	31–40	0.279[b]	−0.278[c]	0.164[c]	−0.173	−0.128
		(3.53)	(1.65)	(−1.71)	(−1.13)	(−0.96)
	41–50	−0.121	−0.034	−0.479[b]	−0.247	0.063
		(−0.71)	(−0.22)	(−3.00)	(−1.43)	(0.43)
	>50	−0.051	0.095	−0.339	−0.378[c]	−0.231
		(−0.30)	(0.69)	(−1.60)	(−1.90)	(−1.31)
Gender						
	Male	−0.122	−0.067	−0.112	−0.097	−0.068
	Female	(−1.47)	(−0.81)	(−1.51)	(−1.28)	(−0.74)
Education						
	No education					
	Primary	0.018	0.056	0.044	−0.048	−0.125
		(0.16)	(0.50)	(0.48)	(−0.41)	(−0.94)
	JHS	0.070	0.052	0.076	−0.020	0.019
		(0.72)	(0.51)	(0.86)	(−0.21)	(0.18)
	SHS	0.101	0.220[a]	−0.567[b]	−0.386[c]	−0.278
		(0.12)	(2.41)	(−4.18)	(−1.78)	(−1.39)
Participation		0.093[a]	0.079[a]	0.021	0.044	0.095[a]
		(2.47)	(2.23)	(0.64)	(1.35)	(2.38)
Partnership		0.179[c]	0.259[b]	−0.012	−0.067	−0.127
		(1.76)	(2.60)	(−0.13)	(−0.78)	(−1.31)
Accountability		0.113[b]	0.163[b]	0.146[b]	0.149[b]	−0.049
		(3.28)	(4.23)	(3.73)	(3.83)	(−1.20)
Fairness		0.148[a]	−0.021	0.089	0.078	0.112
		(2.41)	(−0.32)	(1.0)	(1.21)	(1.48)
Institutional quality		−0.002	0.006	−0.005	0.009	0.026
		(−0.10)	(0.25)	(−0.27)	(0.40)	(0.94)
Sample size		176	176	173	173	173
Pseudo-R^2		0.315	0.257	0.281	0.264	0.192
Wald chi^2		49.48	47.59	44.68	43.89	35.54

Marginal coefficients (computed at means) from logit regression reported above. Each column represents a separate regression for each outcome variable. Each outcome variable is an indicator variable which takes a value one if the respondent responses 'yes' to the question and zero if the respondent answers 'no'. *T* statistics from heteroskedasticity-robust standard errors are reported in brackets

[a] Statistical significance at 5 % level of significance

[b] Statistical significance at 1 % levels of significance

[c] Statistical significance at 10 % level of significance

for livelihood enhancement projects) are 0.062 and 0.225, respectively; both are statistically significant at 1 % level.

However, EEG2 has higher values than EEG1 because while EEG1 is the raw sum and therefore does not take into account all the possible co-variations within the five measures of effective environmental governance outcomes EEG2 does. This means that EEG2 (Table 9) is a better estimation of the five measures of effective environmental governance outcomes

Table 8 Regression of outcome variables on index of EEG

Dependent variable		S-LIVELIHOOD	VOICE	INCIDENCE	U-ACCESS	A-SKILLS
Community						
	Aduasena					
	Binsere	−0.082	−0.011	−0.247	−0.122	−0.473[a]
		(−0.44)	(−0.06)	(−1.33)	(−0.67)	(−2.94)
	Dokyiwaa	−0.314	−0.271	−0.539[a]	−0.442[b]	−0.289
		(−1.46)	(−1.26)	(−3.90)	(−2.35)	(−1.49)
	Yayaaso	0.003	−0.064	−0.202	−0.059	0.060
		(0.02)	(−0.30)	(−0.86)	(−0.30)	(0.29)
Age						
	≤20					
	21–30	0.126	0.071	−0.159	−0.172	−0.124
		(1.48)	(0.74)	(−1.17)	(−1.41)	(−0.94)
	31–40	0.295[a]	0.170[c]	−0.269[c]	−0.182	−0.113
		(4.16)	(1.74)	(−1.74)	(−1.27)	(−0.88)
	41–50	−0.123	−0.049	−0.482[a]	−0.262	0.083
		(−0.76)	(−0.33)	(−3.16)	(−1.55)	(0.58)
	>50	−0.037	0.042	−0.359[c]	−0.408[b]	−0.168
		(−0.24)	(0.28)	(−1.72)	(−2.24)	(−0.89)
Gender						
	Male	−0.083	−0.027	−0.098	−0.086	−0.067
	Female	(−1.02)	(−0.33)	(−1.30)	(−1.10)	(−0.78)
Education						
	No education					
	Primary	0.015	0.008	0.056	−0.045	−0.076
		(0.10)	(0.07)	(0.60)	(−0.38)	(−0.57)
	JHS	0.046	−0.003	0.034	−0.053	0.086
		(0.46)	(−0.04)	(0.38)	(−0.55)	(0.90)
	SHS and higher	0.145	0.219[b]	−0.488[a]	−0.322[c]	−0.194
		(1.39)	(2.12)	(−3.25)	(−1.65)	(0.91)
EEG1		0.065[a]	0.062[a]	0.047[a]	0.057[a]	0.025[b]
		(4.66)	(4.64)	(4.36)	(4.79)	(1.99)
Sample size		176	175	173	173	173
Pseudo-R^2		0.289	0.194	0.224	0.216	0.165
Wald chi^2		30.79	29.64	37.86	34.79	28.79

Marginal coefficients (computed at means) from logit regression reported above. Each column represents a separate regression for each outcome variable. Each outcome variable is an indicator variable which takes a value one if the respondent responses 'yes' to the question and zero if the respondent answers 'no'. *T* statistics from heteroskedasticity-robust standard errors are reported in brackets

[a] Statistical significance at 10 % level of significance

[b] Statistical significance at 5 % level of significance

[a] Statistical significance at 1 % levels of significance

than EEG1 (Table 8). The differences in Tables 8 and 9 suggest that the index computed using the raw sum of the five determinants of effective environmental governance understates its importance.

The regressions reported in Tables 7 through 9 also include various demographic characteristics as controls. The differences in outcomes by locality reported in Table 6 are generally observed in the regressions but are not statistically significant after controlling for other covariates. Recall that outcomes were generally higher in Aduasena than other communities. Column 2 of Table 9 shows residents of Binsere are 4.9 percentage points less likely to report that they have voice in decision making relative to those in Aduasena even though this difference is not statistically significant.

Similar results are found for S-LIVELIHOOD outcome. However, difference by locality for outcomes R-INCIDENCE, A-SKILLS and U-ACCESS were statistically significant in all three tables (last three columns of Tables 7, 8 and 9).

Based on the regression results and analysis effective environmental governance has strong positive effect on environmental governance outcomes. The regressions results show remarkably consistent strong effect of effective environmental governance on outcomes, using various measures of outcomes and different indicators. We conclude therefore that we fail to

Table 9 Regression of outcomes on index of effective environment governance

Dependent variable		S-LIVELIHOOD	VOICE	R-INCIDENCE	U-ACCESS	A-SKILLS
Community						
	Aduasena					
	Binsere	−0.049	0.010	−0.213	−0.088	−0.462[a]
		(−0.26)	(0.05)	(−1.14)	(−0.47)	(−2.82)
	Dokyiwaa	−0.307	−0.306	−0.537[a]	−0.442[b]	−0.286
		(−1.43)	(−1.48)	(−2.81)	(−2.23)	(−1.45)
	Yayaaso	0.024	−0.063	−0.176	−0.034	0.070
		(0.13)	(−0.30)	(−0.75)	(−0.17)	(0.34)
Age						
	≤20					
	21–30	0.124	0.068	−0.163	−0.178	−0.125
		(1.43)	(0.70)	(−1.20)	(−1.43)	(−0.98)
	31–40	0.295[a]	0.171[c]	−0.273[c]	−0.186	−0.110
		(4.16)	(1.75)	(−1.77)	(−1.28)	(−0.85)
	41–50	−0.114	−0.045	−0.490[a]	−0.268	0.085
		(−0.71)	(−0.31)	(−3.21)	(−1.53)	(0.59)
	>50	−0.043	0.038	−0.374[c]	−0.424[b]	−0.169
		(−0.28)	(0.24)	(−1.77)	(−2.33)	(−0.90)
Gender						
	Male	−0.081	−0.024	−0.096	−0.085	−0.067
	Female	(−1.00)	(−0.30)	(−1.21)	(−1.10)	(−0.78)
Education						
	No education					
	Primary	0.013	0.007	0.047	−0.052	−0.077
		(0.11)	(0.06)	(0.51)	(−0.45)	(−0.57)
	JHS	0.042	−0.003	0.033	−0.052	0.086
		(0.45)	(−0.03)	(0.38)	(−0.55)	(0.88)
	SHS	0.129	0.208[c]	−0.518[a]	−0.353[c]	−0.202
		(1.19)	(1.94)	(−3.65)	(−1.75)	(−0.95)
EEG2		0.246[a]	0.225[a]	0.186[a]	0.226[a]	0.096[b]
		(4.76)	(4.55)	(4.64)	(5.01)	(2.07)
Sample size		176	175	173	173	173
Pseudo-R^2		0.267	0.193	0.239	0.234	0.166
Wald chi^2		31.07	28.71	40.38	36.93	28.96

Marginal coefficients (computed at means) from logit regression reported above. Each column represents a separate regression for each outcome variable. Each outcome variable is an indicator variable which takes a value one if the respondent responses 'yes' to the question and zero if the respondent answers 'no'. *T* statistics from heteroskedasticity-robust standard errors are reported in brackets

[a] Statistical significance at 1 % levels of significance

[b] Statistical significance at 5 % level of significance

[c] Statistical significance at 10 % level of significance

reject the second hypothesis that effective environmental governance produces outcomes which are beneficial for communities and the environment.

Conclusion and recommendations

The objective of this paper was to assess the effectiveness of environmental governance of gold mining in Obuasi and Birim North Districts of Ghana and the nature of outcomes effective environmental governance produce for communities and the environment. The results showed that environmental governance was generally effective. The composite index was 53.8 %, which is more than 50 % of the maximum value of the sum of the numerical values of all the variables we used. This means that the results of data analysis failed to reject our hypothesis that 'environmental governance in the mining sector of Ghana is effective'. However, the level of effectiveness was not strong as it is just a little above average (53.8 %). If we had put our prior determination level at 55 % or more the results of data analysis would have rejected our hypothesis. It is thus not surprising that even with this result, environmental challenges of mining and discontent by communities affected by mining is still prevalence in the study area. Effectiveness could mean that the national environmental operating standards are low relative to community expectations.

Effective environmental governance had positive effects on environmental outcomes, i.e. the outcomes which are produced by effective environmental governance were beneficial for communities and the environment. All the five outcome variables had approval scores for more than 50 % of the respondents. Statistically significant differences were observed for all outcomes by locality but not for age and gender. Also, all the variables that measured effective environmental governance, except for institutional quality, had significant effects on environmental outcomes.

Out of the five variables that measured effective environmental governance, accountability consistently had significant impacts on all the five outcome variables while institutional quality had no significant impact on any of the five outcome variables. This means that accountability was considered a very important determinant of effective environmental governance in generating environmental outcomes that are beneficial for communities and the environment and institutional quality was not.

Policy implications

From a policy perspective, the findings of this study suggest that efforts to address community concerns and the environmental challenges of mining should focus on improving the effectiveness of environmental governance. Since effective environmental governance produces outcomes which are beneficial for communities and the environment, policy must focus on expanding and improving the scope of the principles and determinants of effective environmental governance.

This also means that the policy focus must aim at constantly improving upon the dialogue processes which enable and enhance an expression of diverse perspectives, shared understanding and appreciation, collective ownership, and equitable distribution of responsibilities. The governance processes and mechanisms involve a range of actors with disparate interest, capacities and philosophical orientation. This diversity requires policy and practice to enhance the capacity of socially and politically weaker actors as well as the equitable and proportionate distribution of environmental risks and benefits associated with mining. Indeed, the process of governing the environment must involve a constant revelation of the public interest and public power rather than the power of particular actors or group of actors to the disadvantage of other actors and the environment.

Related to the above, policies and programmes for communities affected by mining must disaggregate actors based on a variety of variables such as age, gender, locality, level of education, social status and position, and power to influence. For instance, in matters of gold mining and the environment, although customarily the chief is an epitome of the traditions of a community, his interest is more often diametrically opposed to many ordinary community members. The difference in interest with respect to gold mining was noticeable in the relationship between the chief and ordinary community members at Dokiywaa in the Obuasi Municipality. At the time of this study, AngloGold Ashanti had hired this chief a contractor for weeding roads belonging to the company. Residents of the community complained that in view of the contractual relationship between the chief and the company the Chief has lost his autonomy and authority to defend the collective interest of the community.

Recommendations

On the basis of the findings and policy implications, the paper makes the following recommendations. There is the need to review aspects of laws and regulations governing mining and the environment in order to improve upon effectiveness of environmental governance. In March 2009, MEST commissioned a process aimed at reviewing the Minerals and Mining Act, 2006 (Act 703). This review should lead to the expunging and reformulation of certain provisions in the Act to prevent mining companies from lowering environmental performance standards while externalising their environmental liability to communities and the public. For example, the *stability agreement* in the Minerals and Mining Act gives mining companies protection for an agreed period during which the state cannot review its laws and regulation against a mining company that has investment agreement with the government. The review should also extend to aspects of the environmental laws and regulations. For instance, the confidentiality provision for annual environmental audit reports is a major constraint to public access and opinion about the performance of mining companies on terms agreed under the environmental and social impact assessment (ESIA). The annual environmental audit reports are part of major requirements under the ESIA. The public, including communities affected by mining, ought to have provided information and concerns about the impact of mining. The main essence of the periodic requirement of the audit reports is to enable the regulatory authority work with mining companies, other institutions and the community to ensure compliance with agreed benchmarks under the ESIA in particular and the environmental laws in general. Keeping the reports confidential is limiting the space for public opinion and knowledge on the performance of mining companies and the regulatory authorities with respect to the environment. It may be possible to disaggregate confidential information for protection but not necessarily all pieces of information on the audit reports.

The paper employed a survey approach focusing on four communities affected by mining in two districts in Ghana. The results highlighted issues which, to a certain extent, are valid for improving environmental governance in the mining sector. Further research focusing on single determinants of effective

environmental governance in a broader scale will provide a stronger base for generalisation. For instance, this study revealed that accountability matters a lot in promoting effective environmental governance outcomes in the study area. A focus on accountability for a wider range of communities would provide basis for generalisation in the mining sector of Ghana.

The paper also showed that there were significant differences across localities for all the five determinants of effective environmental governance and also for all outcome variables. This means that in any method that is used to measure outcome variables, the relationship between effective environmental governance and outcomes would be consistent across the different variables. Therefore, this study can be replicated by using the same methodological approach in a different setting or focusing on specific environmental resources affected by mining such as water, land or forest to allow for comparison of results. This will generate additional insight on the general development of environmental governance in the mining sector. Further work could be carried out in the future to find out the motivation of governments, companies, communities and other actors, for adopting and implementing or rejecting these recommendations.

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